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ABSTRACT

This document presents achievement results of a study conducted to determine the effects of diagnostic tests administered to provide immediate feedback and to serve an organizing function in the study of course material. Thirty-three first year college students in biology classes comprised experimental and control groups. Results from the first unit taught indicated no significant increase in student achievement. With a second unit of instruction, however, an increase in student achievement did result for those students using diagnostic organizers. (SL)

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# THE EFFECTS OF DIAGNOSTIC TESTING AS AN ORGANIZING FEEDBACK MECHANISM OF THE ACHIEVEMENT OF FIRST YEAR COLLEGE BIOLOGY STUDENTS

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THE EFFECTS OF DIAGNOSTIC TESTING
AS AN ORGANIZING FEEDBACK MECHANISM ON THE ACHIEVEMENT
OF FIRST YEAR COLLEGE BIOLOGY STUDENTS

In 1968, Benjamin Bloom coined the term "mastery learning", and applied it to a strategy of classroom teaching which has been the subject of examination in a number of research studies (Block 1971, 1973). In these studies and others, substantial gains in student achievement have been attained, and been attributed to the use of the mastery strategy, at the heart of which lies a diagnostic-prescriptive process.

The intent of this study was to test the feasibility and effectiveness of a strategy not totally unrelated to mastery learning, yet dissimilar in that the prescriptive process became each individual student's responsibility, and no remediation activities were administered. Performance objectives in conjunction with objective-specific, diagnostic tests (diagnostic organizers) were designed and administered to provide immediate feedback and to serve an organizing function in the study of course material. The manner in which coursework difficulties were resolved was left to the student. Self diagnosed problems which a student identified through the use of a diagnostic organizer could be resolved in any number of ways: further study, student-teacher interaction, additional study of supplementary materials, or any manner in which a student chose to approach the problem. No specifically prepared remedial assignments were available, however. The main purpose of this study was to determine what effects the administration of a diagnostic organizer technique would have on student achievement.

## PROCEDURE

Two undergraduate college level Biology classes at the University of Georgia formed the experimentally available population for this study. The classes, which were in progress when the study began, were largely composed of female, preservice, elementary science teachers, and were kept intact. No randomization procedure was possible.

The total number of students enrolled in both classes was thirty-three. From those, thirty complete data profiles were produced. The experimental group was composed of twenty students. The control group was composed of ten students. Information further defining the total student population is located in Table 1.

Diagnostic organizers were administered to the experimental group on a daily basis, over a three week period, and through two units of instruction. Both the experimental and control classes met three days a week for a one-hundred minute period each day for the duration of that period.

The diagnostic organizers and unit examination materials were developed with the collaboration of both course instructors, to aid in assuring content validity, and probable reliability. A list of the unit objectives on Ecological Interaction, and a diagnostic organizer instrument are contained in the Appendix. The unit examination reliability figures are listed in Table 2.

Unit objectives were sequenced and grouped according to which would be taught during each class period. Diagnostic organizers which tested each objective were then developed for each group of objectives to be taught during a class session. For example, if three objectives were taught during a class period, then the diagnostic organizer would contain a minimum of three questions, with one question testing each objective.

TABLE 1

Population Defining Mean Scores

| STUDY POPULATION | SAT V | SAT M | TOTAL SAT | HIGH SCHOOL GRADE POINT AVERAGE | COLLEGE GRADE POINT AVERAGE | COLLEGE CREDIT HOURS COMPLETED |
|---|---|---|---|---|---|---|
| (33 students: 31 female 2 male) | 425 | 475 | 900 | 3.005 | 2.61 | 83 |

TABLE 2

Split Halves Reliability Figures of Animal Behavior, Animal Behavior Retention and Ecological Interaction Test Instruments

| Animal Behavior | Animal Behavior Retention | Ecological Interaction |
|---|---|---|
| .698 | .787 | .599 |

The diagnostic organizer was composed of three pages: 1) a diagnostic quiz, 2) a response sheet, and 3) an answer key. The answer key was attached to the others such that it faced the opposite direction. The students were instructed to use the response sheet to record their answers, then tear off the answer key, turn it over, and compare it with their own responses. They were then permitted to make any notes which they felt would benefit themselves. This process took an average of ten minutes. Pages one and two were collected, and the class was dismissed.

The incorrect responses were tabulated in order to provide feedback for the instructor, however, no papers were graded, and no scores were recorded on the basis of these tests. At the beginning of the next class period, ten minutes were available to accommodate student questioning before continuing with the next group of objectives. If no questions were raised, the next block of instruction was immediately begun.

With the exception of the diagnostic testing procedure, the control group received identical instruction. The twenty additional minutes (approximately) which the control group possessed were utilized by providing additional break time, having several minutes of additional instructional time, and dismissing class earlier than required.

Upon completion of a unit, the unit examination was administered. The unit examination question-types were identical to those which had been utilized in the diagnostic instrument, and had been developed simultaneously with them. Both units followed the identical summative examination procedure, with one minor exception. The data collected on the Ecological Interaction unit examination was taken from a larger examination which covered three units of instruction, whereas the Animal Behavior unit examination covered only that unit's work.

Pre-treatment data collection included Scholastic Aptitude Test (SAT) scores. These figures were obtained from University of Georgia student records. SAT scores, utilized as an indication of general ability, allowed blocking students into high and low groupings (900 and above = high; below 900 = low). This was done to determine if a particular ability group was affected to a greater extent than the other. Data were collected on both unit examinations and on a retention examination covering the Animal Behavior unit.

## RESULTS

Mean scores for the Animal Behavior unit examination are given in Table 3. Analysis of these data indicate non-significant treatment effects, yet a significant treatment X ability interaction (see Table 4). In order to determine the nature of this interaction, the cell means were graphed as Figure 1.

TABLE 3

Cell, Marginal, and Grand Mean Scores
For the Animal Behavior Unit Examination

| | | Ability | | |
|---|---|---|---|---|
| | | High | Low | |
| TREATMENT | Experimental | 46.6 | 43.6 | 45.25 |
| | Control | 40.9 | 45.3 | 43.10 |
| | | 44.81 | 44.21 | 44.53 |

TABLE 4

Analysis of Variance on Animal Behavior
Unit Examination Scores

| Sources | Degrees of Freedom | Mean Squares | F Ratios | Significances of F Ratios |
|---|---|---|---|---|
| Treatment, (T) | 1 | 30.032 | 2.126 | 0.153 |
| Ability, (A) | 1 | 1.888 | 0.134 | 0.999 |
| T x A | 1 | 90.466 | 6.404 | 0.017 |
| Explained | 3 | 41.057 | 2.906 | 0.053 |
| Residual | 26 | 14.12[illegible] | -- | -- |

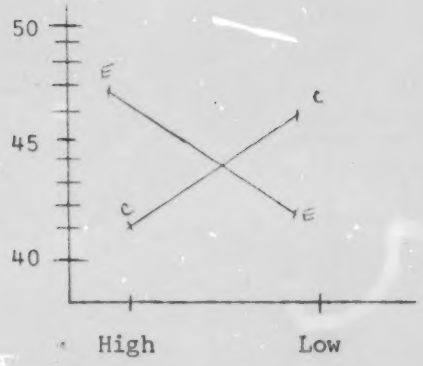


Figure 1. Treatment X ability interaction of the animal behavior unit examination

Mean scores for the Animal Behavior retention examination are given in Table 5. Analysis of these data also fail to indicate any significant treatment effects (see Table 6). The same type of Treatment X ability interaction which occurred with the Animal Behavior unit examination continued to exist within these data.

TABLE 5

Cell, Marginal, and Grand Mean Scores
For the Animal Behavior Retention Examination

| | | Ability | | |
|---|---|---|---|---|
| | | High | Low | |
| TREATMENT | Experimental | 40.0 | 37.6 | 39.0 |
| | Control | 35.2 | 39.0 | 37.1 |
| | | 38.57 | 38.15 | 38.37 |

TABLE 6

Analysis of Variance on Animal Behavior
Retention Examination Scores

| Sources | Degrees of Freedom | Mean Squares | F Ratios | Significances of F Ratios |
|---|---|---|---|---|
| Treatment, (T) | 1 | 23.590 | 2.033 | 0.162 |
| Ability, (A) | 1 | 0.839 | 0.072 | 0.999 |
| T x A | 1 | 64.354 | 5.546 | 0.025 |
| Explained | 3 | 29.753 | 2.564 | 0.075 |
| Residual | 26 | 11.604 | -- | -- |

Table 7 shows the mean scores on the Ecological Interaction examination. The F Ratios indicate significant treatment effects in favor of the experimental group at the .008 level (see Table 8). No treatment X ability interaction occurs in these data. Also, neither ability group outperformed the other to any significant extent.

TABLE 7

Cell, Marginal, and Grand Mean
Scores for the Ecological Interaction Unit Examination

| | | Ability | | |
|---|---|---|---|---|
| | | High | Low | |
| TREATMENT | Experimental | 40.5 | 37.4 | 39.15 |
| | Control | 33.6 | 35.0 | 34.28 |
| | | 38.37 | 36.57 | 37.53 |

TABLE 8

Analysis of Variance on Ecological Interaction Unit Examination Scores

| Sources | Degrees of Freedom | Mean Squares | F Ratios | Significances of F Ratios |
|---|---|---|---|---|
| Treatment, (T) | 1 | 151.376 | 8.197 | 0.008 |
| Ability, (A) | 1 | 18.849 | 1.021 | 0.323 |
| T x A | 1 | 33.653 | 1.822 | 0.186 |
| Explained | 3 | 69.773 | 3.778 | 0.022 |
| Residual | 26 | 18.467 | -- | -- |

## DISCUSSION

The data collected from the use of diagnostic organizers are conflicting. In the Animal Behavior unit, the first unit to be taught, no significant increase in student achievement occurred as a result of the use of the diagnostic organizer technique. In the Ecological Interaction unit, however, a reversal of those results occurred. An increase in student achievement significant at the .008 level did result for those students who had experienced the use of diagnostic organizers. Perhaps this is an indication that students do not immediately become completely aware of the function and proper usage of the diagnostic organizer. Perhaps the acquisition of a particular level of understanding in a subject area is more positively enhanced through the function performed by diagnostic organizers.

The diagnostic organizer serves the function of a continuous organizational tool. Used in conjunction with performance objectives, it's purpose is to allow students to pinpoint their difficulties or understandings with

regard to the more important (i.e., testable) material presented in the classroom. In practice, the use of diagnostic organizers is quite simple. A set of objectives, and multiple parallel test items are all the materials that are required.

An indication of the success of this classroom teaching strategy has been obtained through the results of this study. If, after further study, the diagnostic organizer concept proves to be both effective and reliable, then it's simplicity will greatly facilitate it's adoption as a classroom teaching strategy.

## REFERENCES

Block, J. (Ed.) Mastery learning: theory and practice. New York: Holt, Rinehart and Winston, 1971.

Block, J. Mastery learning in the classroom: an overview of recent research. Paper presented at the American Educational Research Association Annual Meeting, New Orleans, Louisiana, February, 1973.

Bloom, B. Learning for mastery. Evaluation Comment, May, 1968, 1, Center for the Study of Evaluation, University of California, Los Angeles.

APPENDIX

ECOLOGICAL INTERACTION
Performance Objectives

Upon completion of this unit students should be able to:

1. Given an ecosystem, label the components as producers, decomposers, primary consumers, or secondary consumers.

2. Given several food chains, construct a food web.

3. Given the components of a foodchain, construct the pyramid of energy for that food chain.

4. Demonstrate an understanding of the interaction of abiotic and biotic components of an environment by reproducing the carbon, phosphorus, or nitrogen cycles.

5. Design a hypothetical ecosystem in terms of producers, decomposers, and consumers.

6. Diagram or identify the relationship between biotic potential and environmental carrying capacity.

7. When given a list of population limiting factors, classify them as density-dependent or density-independent.

8. Recognize or define the following terms in view of ecological relationships:

   competition commensalism parasitism
   predation mutualism

9. Given any organism, briefly describe its ecological niche.

10. Identify or define ecological succession, and determine the stage of ecological succession which exists in a given biological community.

11. Identify or cite examples of homeostatic mechanisms operative at the population level of organization within an ecosystem.

12. Given an example of a situation in which man rapidly changes the environment, cite or select possible ecological consequences.

BIO 105
ECOLOGICAL INTERACTION--DIAGNOSTIC TEST
Objectives 10, 11, 12

Place the letter of the correct answer in the blank to the left of the question.

____1. A marshy area which was once a pond can be considered to be:

a. in the early to middle stages of succession
b. in the very first stages of succession
c. in the late stages of succession
d. an exception to the processes of succession

____2. If all living things in an area were destroyed, which would be the first to reappear?

a. oaks or maple trees
b. grasses
c. small animals
d. cactus or lizards

List 3 examples of homeostatic mechanisms operative at the population level of organization within an ecosystem.

3.
4.
5.

6. What are several possible ecological consequences which could result from the building of a dam?

BIO 105
ECOLOGICAL INTERACTION--DIAGNOSTIC TEST ANSWER SHEET
Objectives 10, 11, 12

DIRECTIONS: Please use this sheet to record your answers to the diagnostic quiz questions. DO NOT WRITE ON THE QUIZ ITSELF. When you finish the quiz, check your answers with the correct answers on the third page. You may make any notes that you wish to make on page three. Before you leave class, tear off page three and keep it to study by.

OBJECTIVE X

1
2

OBJECTIVE XI

3
4
5

OBJECTIVE XII

6

BIO 105
ECOLOGICAL INTERACTION--DIAGNOSTIC TEST ANSWER SHEET
Objectives 10, 11, 12

DIRECTIONS: Please use this sheet to record your answers to the diagnostic quiz questions. DO NOT WRITE ON THE QUIZ ITSELF. When you finish the quiz, check your answers with the correct answers on the third page. You may make any notes that you wish to make on page three. Before you leave class, tear off page three and keep it to study by.

OBJECTIVE X

1 A
2 B

OBJECTIVE XI

3 COMPETITION
4 PARASITISM
5 PREDATION

OBJECTIVE XII

6 flooding of an area in an advanced stage of succession situation
modification of water temperature
upsetting of the migratory paths of land animals and fish